

MECHANISTIC STUDIES OF PHOTOTHERMAL AGING

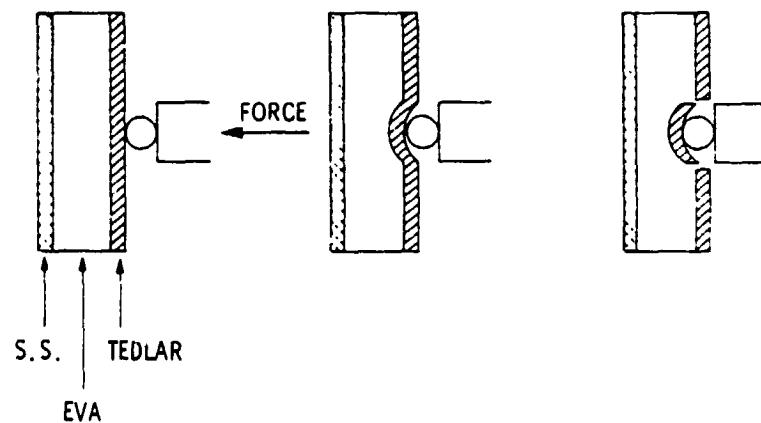
JET PROPULSION LABORATORY

R. H. Liang

Objective and Approaches

- OBJECTIVE
 - TO DEVELOP METHODOLOGY WHICH IS CAPABLE OF PREDICTING LONG-TERM BEHAVIOR OF POLYMERIC MATERIALS FOR OUTDOOR APPLICATIONS
- APPROACH
 - TO UNDERSTAND MECHANISMS OF DEGRADATION
 - TO DEVELOP VALID ACCELERATED TESTING FOR MATERIAL EVALUATION

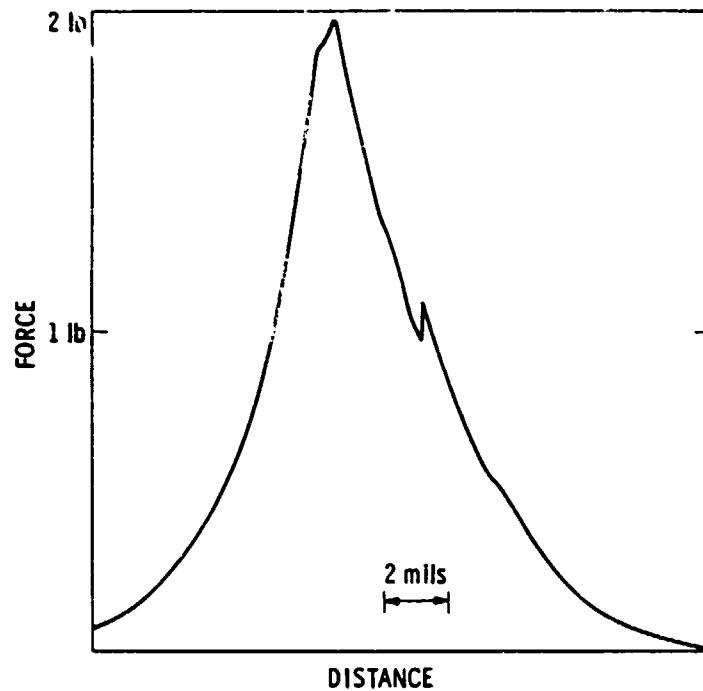
Compression Testing of Tedlar/EVA/Stainless Steel Module



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RELIABILITY PHYSICS

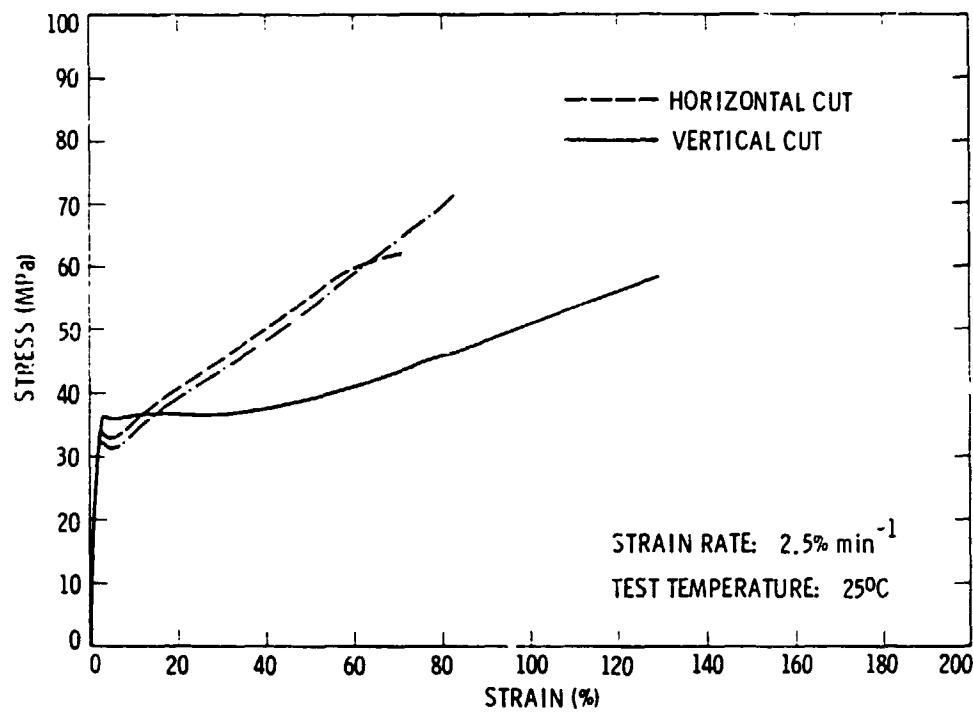
Compression Test of Outdoor Aged (500 Days)
Tedlar/EVA/Stainless Steel Module



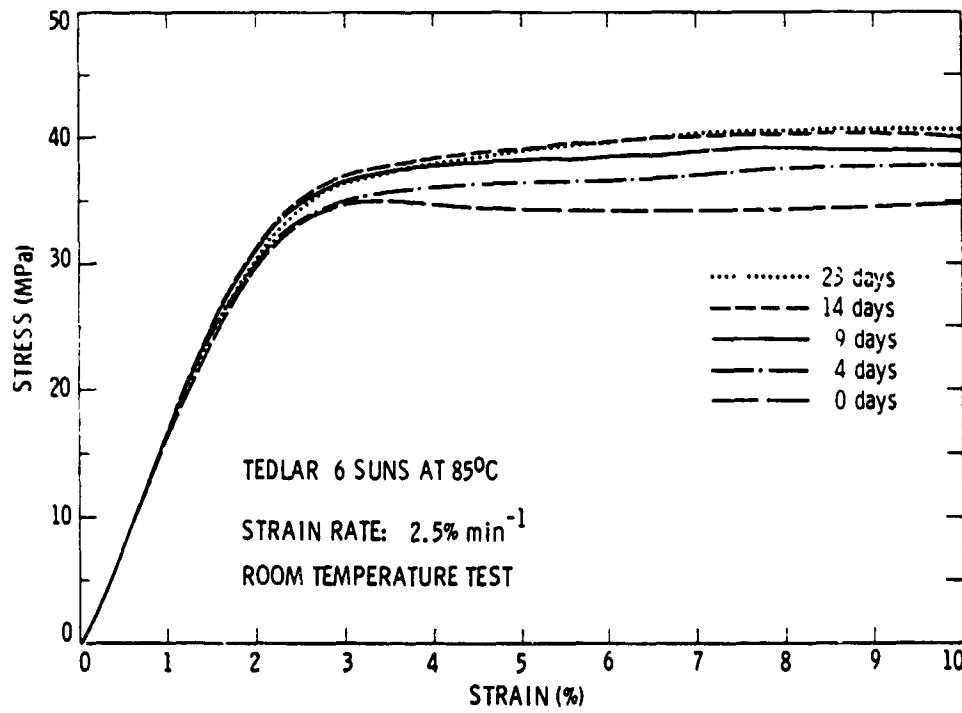
Compression Testing of Tedlar/EVA/Stainless Steel Module

SAMPLE	FORCE AT BREAK (lb)
CONTROL	31
OUTDOOR (500 days)	1.2
850°C, 8 SUNS (6.5 days)	1.0
980°C, 5.5 SUNS (6.5 days)	DID NOT BREAK

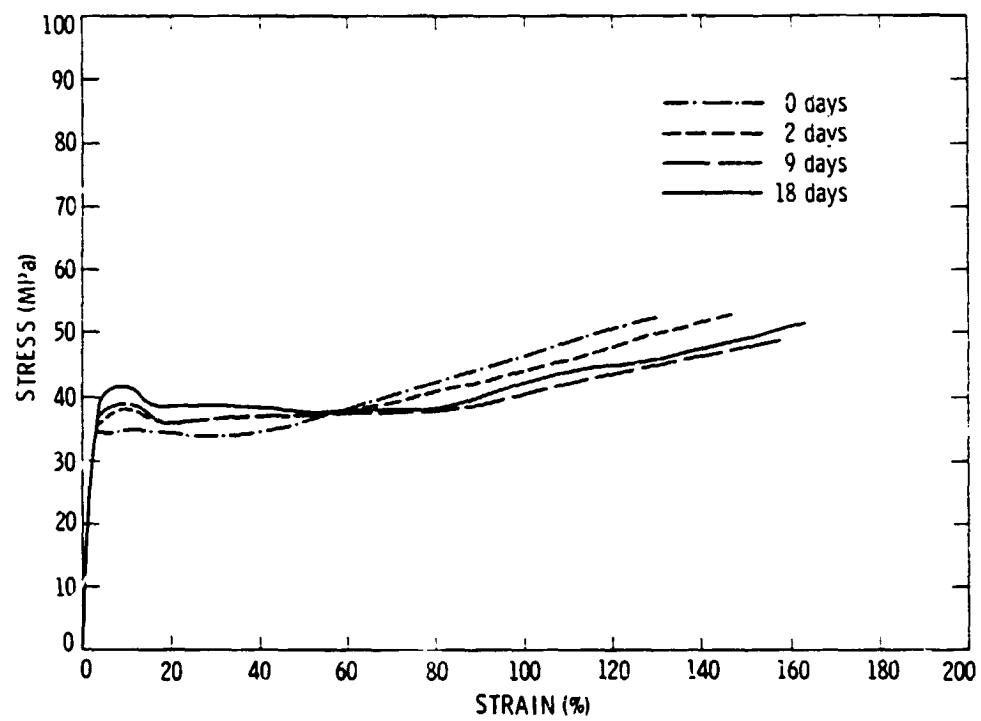
Tedlar Controls (As Received)



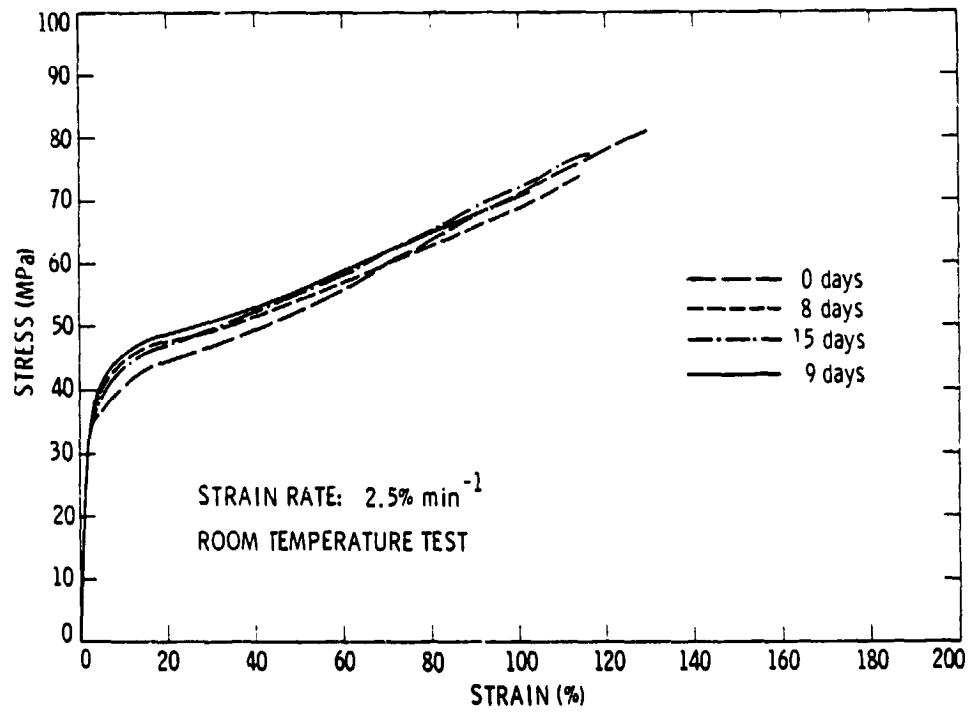
Stress-Strain as a Function of Exposure Time (Days)



Stress-Strain Curve of Tedlar Aged at 6 Suns and 85°C



Stress-Strain Curve of Laminated Tedlar Aged at 6 Suns and 85°C



RELIABILITY PHYSICS

Conclusions for Tedlar Studies

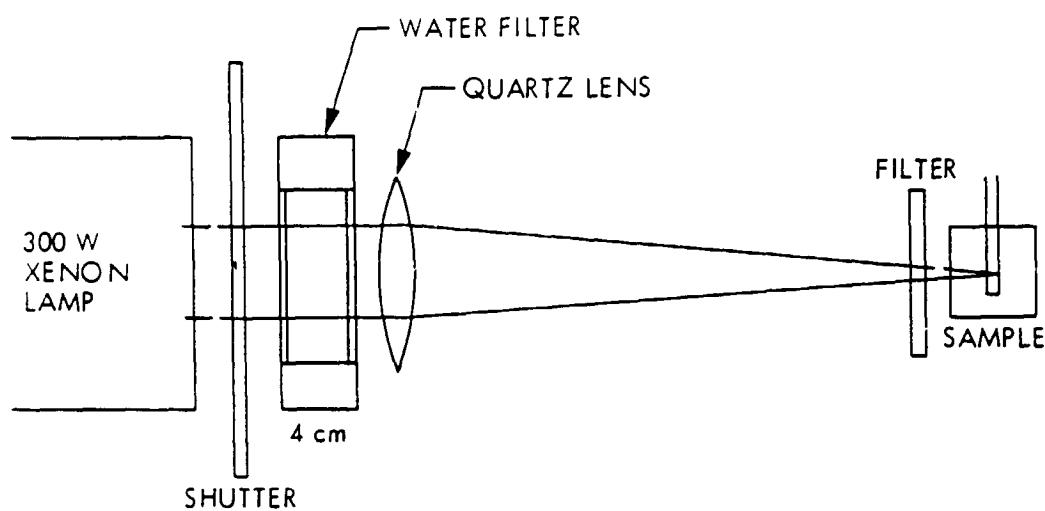
- TEDLAR DAMAGE IS CHIEFLY UV DRIVEN
- QUAL TEST TEMPERATURE SHOULD BE $\leq 85^{\circ}\text{C}$
- DIAGNOSTIC TECHNIQUE HAS BEEN DEVELOPED
- SYNERGISTIC EFFECT OF TEDLAR AND EVA IS BEING EVALUATED

Mechanistic Studies of Photothermal Degradation

- OBJECTIVE
 - TO STUDY MECHANISTIC PATHWAYS OF PHOTOTHERMAL DEGRADATION
 - TO DETERMINE DEGRADATIVE REACTION RATES FOR MOLECULAR MODELING
- APPROACH
 - IDENTIFY FAILURE MODES
 - DETERMINE DEGRADATION MECHANISM
 - DEVELOP ACCELERATING CRITERIA
 - DEVELOP ACCELERATING METHODOLOGY
 - DEVELOP DIAGNOSTIC TECHNIQUES

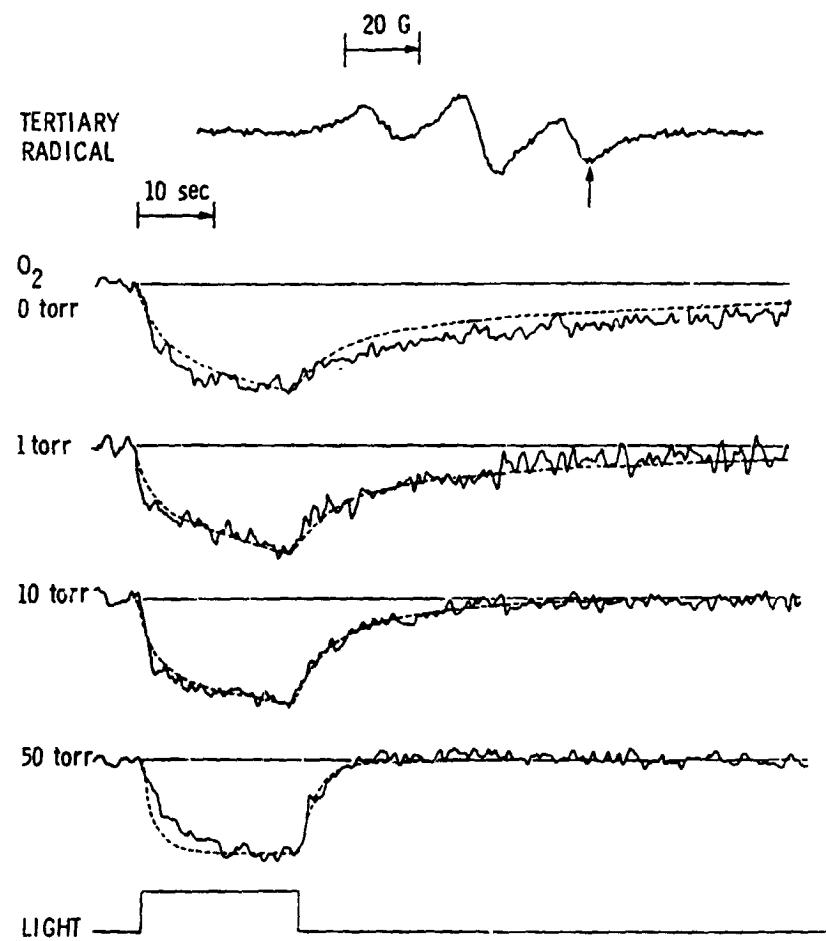
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Flash Electron Spin Resonance Apparatus

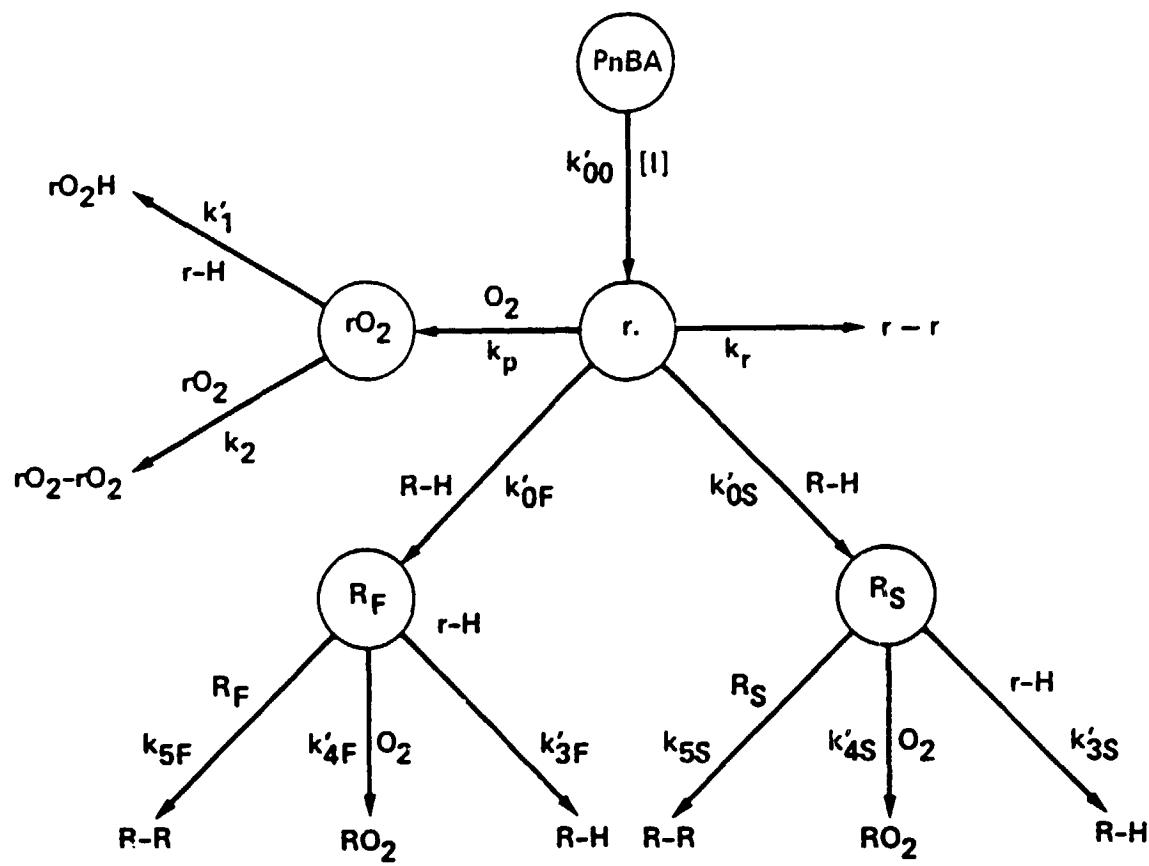


RELIABILITY PHYSICS

Kinetic Studies of Photogenerated Tertiary Radical
at Various Oxygen Pressures



Mechanism of Photooxidation of Poly-n-Butyl Acrylate



RELIABILITY PHYSICS

Kinetic Parameters of Poly-n-Butyl Acrylate Photooxidation

RADICAL	RATE CONSTANTS (25°C)
INTERMEDIATE	$k_p' = 700 \text{ l m}^{-1} \text{s}^{-1}$ $k_r' = 8 \times 10^5 \text{ l m}^{-1} \text{s}^{-1}$
TERTIARY	$k_{0F}' = 5 \times 10^{-1} \text{ s}^{-1}$ $k_{0S}' = 1 \times 10^{-1} \text{ s}^{-1}$ $k_{3F}' = 1.3 \times 10^{-1} \text{ s}^{-1}$ $k_{3S}' = 8 \times 10^{-3} \text{ s}^{-1}$ $k_{4F}' = 700 \text{ l m}^{-1} \text{s}^{-1}$ $k_{4S}' = 300 \text{ l m}^{-1} \text{s}^{-1}$ $k_{5F}' = 5 \times 10^4 \text{ l m}^{-1} \text{s}^{-1}$ $k_{5S}' = 3 \times 10^3 \text{ l m}^{-1} \text{s}^{-1}$
PEROXY	$k_1' = 2 \times 10^{-2} \text{ s}^{-1}$ $k_2' = 5 \times 10^4 \text{ l m}^{-1} \text{s}^{-1}$